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CRDL TECHNICAL MEMORANDUM 1-34

HUMAN FACTORS EVALUATION OF  
THE F24 G1 MUNITION

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John W. Lewis

October 1965

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6 HUMAN FACTORS EVALUATION OF THE E24 CS MUNITION.

9 Test Report

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~~Experimental Medicine Division~~  
~~Directorate of Medical Research~~

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#### FOREWORD

The work described in this memorandum was authorized under Project 1C522301A079, Non-Defense Medical Aspects of Chemical Agents (U). This work was started and completed in July 1965.

The human subjects in the tests conducted by this installation are enlisted US Army volunteers. There is no coercion or enticement to volunteer. The most stringent medical safeguards surround every human test.

#### Acknowledgment

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## HUMAN FACTORS EVALUATION OF THE E24 CS MUNITION

### I. INTRODUCTION.

The Cartridge, 40 mm, Riot Control, CS, E24 is designed to be used by federal law enforcement agencies and the armed forces. It is a self-contained munition that can be fired from the M79 grenade launcher or, in situations where the M79 may not be immediately available, it can be fired by hand (Fig 1 & 2).

The assembled cartridge is approximately 8 inches long with an outer diameter of 1-1/2 inches and weighs about 1/2 lb. It consists of: (1) a modified M128A1 aluminum hand-held parachute signal case, (2) a natural rubber latex body containing 95  $\pm$  10 gm of CS mix with a 2-1/2 sec pyrotechnic delay, (3) a close fitting aluminum cartridge cap containing a steel firing pin in its base, and (4) 1-1/2 gm A4 black powder as a propellant initiated by an M39A1 or Mark 5 percussion primer located in the base of the cartridge case (Fig 3). For this test the cartridge contained red smoke rather than CS (Fig 4). Fig 4 also shows to better advantage the tape which seals the round.

The item is carried in a cloth bandolier that holds four munitions and has tie tapes to position it around the shoulders or waist of the user. (Fig 5)

The test described below was designed and monitored by the Human Factors Engineering Branch for the Field Evaluation Division, CRDL, as a part of the Engineering Design test of this item.

### II. METHOD.

#### A. Subjects.

Six Medical Research Volunteers were obtained from the volunteer pool available to these laboratories. Information regarding the service background and experience of each subject is shown in Table 1. All subjects wore the M17 protective mask while firing. Two subjects normally wear glasses all the time, but they had to remove them when they donned the mask.

#### B. Task.

Each of the six subjects was to fire eight rounds of E24 CS munition at two different targets and by two different methods. The first target consisted of a 20-ft by 30-ft rectangle on the ground, 75 m to the leading edge with the narrow side facing the subject. A large upright rectangle of plywood was placed a short distance from the far end for orientation. This was felt to be reasonable since in actual use targets would be upright individuals, and the possible enhancement of distance estimation would be similar.

Target 2 was an upright sheet of plywood 2-1/2 ft x 6 ft, designed to simulate a window opening, 45 m from the subject, raised approximately 2 ft off the ground and oriented vertically with respect to the longer side. The field use of the device and the reason for the test were explained to the subjects; they were then instructed in the firing method orally and by demonstrations. The subjects were told that the sights on the M79 were inappropriate with this cartridge and a shotgun-type aiming method should be used. This may not have been a completely valid assumption since some observers later felt that in the one rapid fire test the sight aided the subject. Each subject fired one round in the M79 for familiarization.

Two bandoliers were tied on each subject, one about the shoulders and one around the waist (Fig 6). Subjects were instructed to remove a round from the bandolier and prepare it for firing. For the M79 launcher this consists of removing the tape that holds the cap to the body of the munition and then discarding it and the cap. On the hand-held option, the plastic extractor sleeve and the tape are removed and discarded. The cap is removed and repositioned over the base of the munition to act as a firing pin. For test no. 3 (hand-held munitions at 75 m) no bandoliers were used to conserve time. The M79 launcher was first used to fire on each target, and then the hand-firing method was used. In addition, one subject fired eight rounds of rapid fire with the M79 launcher after the rounds had been prepared and placed in the bandoliers. Where misfires occurred, subjects were given another round; only actual firings were tabulated. All firings were recorded on 16-mm film.

Target choice was somewhat arbitrary and no attempt was made to assure a cloud of agent over the target, which would perhaps have been a more realistic but more difficult task than merely firing at a target.

### III. RESULTS.

Results are shown in Table 2. When the subjects fired at the horizontal target 75 m away by the hand-held method, only 6 of 44 rounds were hits; 21 of 48 rounds fired from the launcher were hits. Results when the target was a simulated window were even worse. Out of 48 rounds, there were no hits when the cartridge was hand-held and only 2 out of 48 when the launcher was used. In the rapid fire test (122 sec for 8 rounds against the simulated window), there was 1 hit.

Those subjects who normally wear glasses did no worse than those who do not.

### IV. DISCUSSION.

#### A. Bandolier.

The cloth bandolier that was used is also an R & D item, designed to be a throw-away unit. In general the subjects thought it was adequate.

They had some trouble removing the munitions from the pockets. The testing personnel found it even more of a problem to reload the bandolier pockets. The basic design is adequate, and such difficulties as did occur can be prevented by slightly increasing the pocket size. The pockets of the two bandoliers that were available were somewhat smaller than design specifications call for and had to be torn open for ease of access (Fig 7). The placement of the bandolier for ease of use depends upon the individual's agility, clothing, and particular personal equipment arrangement.

B. Munition.

Removing the tape used to attach the cap to the body of the munition and to seal the unit against moisture is difficult and time consuming. A review of the film indicates that most of the time from starting to prepare the item for firing to the point of actual firing was spent in removing the tape.

Removal of the plastic sleeve was easy, so easy in fact that a few of them came off in the launcher without ejecting the round. This presents little problem, however, since the round is still easily removable even after firing, although at some small cost in time.

C. Operation.

The firing of the round in the M79 launcher was done without incident, none of the subjects reporting any difficulties and none of the testing personnel observing any. The films do not indicate any excessive recoil of the weapon. However, training is required to sight and fire the weapon.

As was noted above, the subjects were not using the M79 sights for firing. The feeling of some of the testing personnel is that these sights should be helpful with more training in their use with the specific round. This was perhaps one of the reasons for the poor showing in target accuracy, but the major reason was probably the relative lack of consistency of range even when the item was machine-fired. The cartridge was designed as an area weapon and, as such, limited accuracy is acceptable, especially when used against rioters in the open. The poor showing on a simulated window target at a short range seems to delimit its usefulness to a greater extent. The effective use of this weapon against this type of target will require considerable practice.

The option of hand-firing the item appears to require caution. While not excessively loud (the noise level has not been reported), it seems louder to the subject when fired by hand. It is less accurate. Table 2 indicates hits and misses only. Hand-firing caused greater missed distance, however, than did firing by means of the M79 launcher. Observation of the film indicates that most subjects tended to be afraid of injury by the munition when it was fired by hand. One subject was unable to complete a test because of an injured hand.

Most subjects had to strike the projectile several times to fire it, although the actual impact force required is rather small. In one case the munition slipped from the subject's hand after firing--a disconcerting, if not a possibly dangerous, situation. From analysis of the film, it appears that the subjects, apprehensive of recoil, were beginning to withdraw their hands even before they struck the cap. A certain amount of over-reaction was apparent in the withdrawal reaction.

The film sequences and other information indicate that the time interval between striking the cap until the munition fired and the immediate recoil impulse was a few milliseconds, while the human reaction is probably an order of magnitude greater. This would mean that the subject has no chance of escaping the recoil. This is a finding to be considered in training for hand-firing the munition, and emphasizes the necessity for careful training. Those individuals who strike the cap with the heel of the hand are prone to injury since the recoil is totally absorbed by the hand and wrist. If the cap is struck at the junction of the fingers and the palm, the recoil forces this portion of the hand backwards, but there is sufficient flexibility to escape injury. Tapping the cap only with the fingers is generally insufficient to cause a detonation. Other methods of detonating the munition (Fig 8), while probably less hazardous to the subject, should generally be less accurate than the hand-firing method illustrated in Figure 2, but this assumption has not been tested.

#### V. CONCLUSIONS.

1. The Cartridge, 40 mm, Riot Control, CS, E24 can be fired by the M79 launcher and by hand.
2. Accuracy of the device in the hands of relatively untrained personnel is low.
3. Accuracy is much less when fired by hand than when fired by means of the M79 launcher.
4. The design of the bandolier is adequate, but some care is needed to insure quality control of pocket size.
5. The sealing tape on the munition is difficult to remove.
6. Hand-firing has some degree of hazard and should not be resorted to routinely.
7. Training, as differentiated from orientation in the use of the device, including test firings, is needed for all personnel who will be required to use it.



TABLE 1

## BACKGROUND INFORMATION ON SUBJECTS

Subject	Age yr	Rank	Amount of service mo	Type of service	Wears glasses*	Experience with mask			Fired weapons while wearing
						Total time worn	Longest time worn	Time since last worn mo	
1	23	Pfc	10	Basic	All the time	4	2	8	No
2	24	Pfc	16	Medical Battalion	All the time (contact lenses)	2	1	3	No
3	26	Sp4	33	Medical (Field Service)	Only for reading	10	1/2	2	Yes (Basic)
4	19	Pfc	22	Signal	No	4	1	6	Yes (Basic)
5	22	Pvt E-2	8	STRAC (Medical)	No	5	1/2	2	Yes
6	24	Sp4	18	Medical	All the time	2	3/4	14	No

\* Not worn under mask.

TABLE 2  
ACCURACY OF CARTRIDGE FIRINGS

Subject number	Target: 20-ft x 30-ft area 75 m from subject				Target: 2-1/2-ft x 6-ft simulated window 40 m from subject			
	Hand-held		Launcher		Hand-held		Launcher	
	Hits	Misses	Hits	Misses	Hits	Misses	Hits	Misses
1	0	8	4	4	0	8	1	7
2	2	6	4	4	0	8	0	8
3	0	4*	0	8	0	8	0	8
4	2	6	3	5	0	8	0	8
5	2	6	6	2	0	8	1	7
6	0	8	4	4	0	8	0	8

\* This subject only fired four hand-held rounds at this target because he injured his hand.



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FIGURE 1

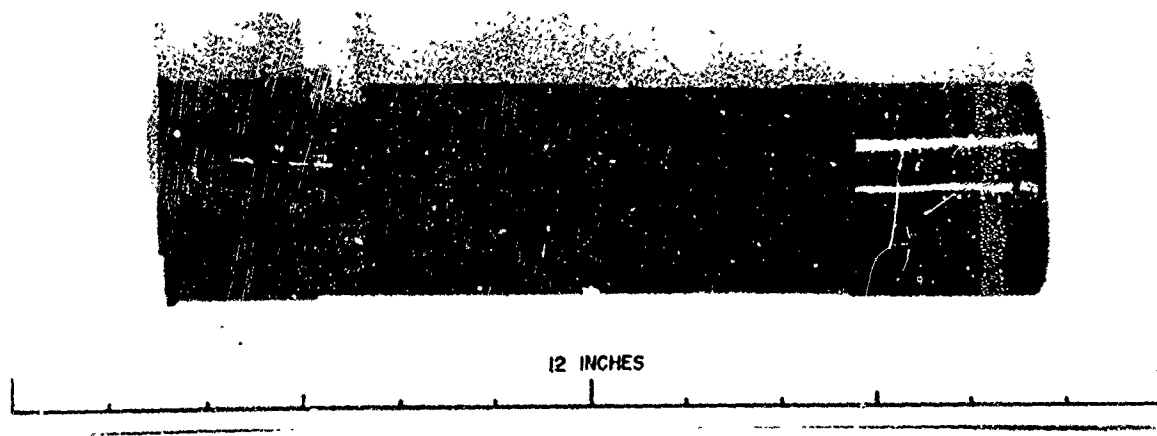
M79 GRENADE LAUNCHER AND E24 CS CARTRIDGE



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FIGURE 2

HAND-FIRING OF E24 CS CARTRIDGE



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FIGURE 3  
E24 CS CARTRIDGE

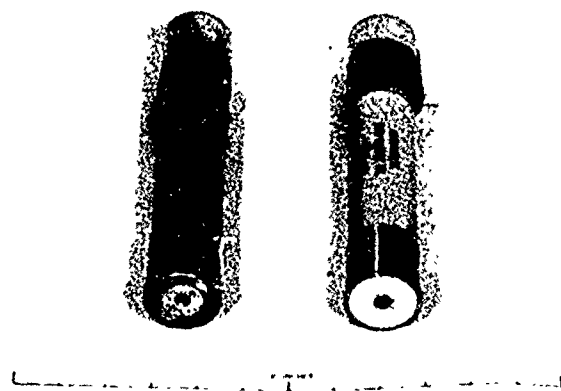


FIGURE 4  
E24 CS CARTRIDGE (left) AND E25 RED SMOKE CARTRIDGE (right)



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FIGURE 5  
BANDOLIER FOR CARRYING E24 CS CARTRIDGE



FIGURE 6  
POSITIONING OF BANDOLIERS



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FIGURE 7  
TORN-OPEN BANDOLIER



FIGURE 8  
THREE METHODS OF FIRING THE E24 CS CARTRIDGE

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11. SUPPLEMENTARY NOTES Non-Defense Medical Aspects of Chemical Agents (U)	12. SPONSORING MILITARY ACTIVITY N/A	
13. ABSTRACT A human factors evaluation of the Cartridge, 40 mm, Riot Control, CS, E24 revealed that this device can be fired by the M79 launcher and by hand. However, accuracy of the device in the hands of relatively untrained personnel is low, and is much less when fired by hand than when fired from the M79 launcher. Also, hand-firing has some degree of hazard and should not be resorted to routinely. The design of the handolier is adequate, but quality control of pocket size is necessary. The sealing tape on the munition is difficult to remove. Training, as differentiated from orientation in the use of the device, including test firings, is needed for all personnel who will be required to use it.		
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